reference to the illustration. It is true this is well lettered, but no explanation is furnished as to what each letter denotes. Many of the figures prepared specially for the book from photographs are of little use.

In a word, the book would have been more acceptable if the author had confined his attention to the matters really included in the title, and had supplied better illustrations.

EXPERIMENTAL SCIENCE FOR BEGINNERS.

Practical Chemistry. By Walter Harris, M.A., Ph.D. Vol. i. Measurement. Vol. ii. Exercises and Problems. Vol. iii. Qualitative and Quantitative Analysis. Pp. x+91; ix+172; vii+146. (London: Whittaker and Co., 1903.)

THERE are probably few teachers, who, with half-a-dozen pupils and plenty of time to devote to them, would not prefer the oral to the book process of imparting the elements of experimental science. Yet when the number in a class is large, and laboratory work is limited to one or two hours a week—the usual order of things in schools—the demonstrator must be relieved by the aid of some form of printed instructions.

In compiling a book of this kind, the chief difficulty which presents itself is to know how much to tell about the processes, and how much to leave to the pupil's intelligence and initiative.

Given the budding philosopher and plenty of time, very little book direction is necessary, and he may safely be left to worry out details for himself. The everyday youth is not a philosopher, and if, in addition, he has only one hour a week in the laboratory, he must be helped to his results in a very substantial manner, to enable him not only to absorb a variety of facts in the time at his disposal, but (and this is equally important) to avoid the discouraging consequences of repeated experimental failures. These points have been recognised in the three little volumes which together make up Dr. Harris's "Practical Chemistry." Vol. i. deals really with elementary physics, and contains exercises in measurement of length and volume, mass and density. Vol. ii. contains easy qualitative and quantitative experiments in chemistry. The third volume contains the elements of qualitative and quantitative analysis, in reference to which the author laconically remarks that "for those who do not require this section for examination purposes, it should be omitted." The experiments in the first two volumes are numerous, simple, and suggestive, and well adapted for a school laboratory, and there are many things which will be found of value to the teacher as well as to the student.

One feels compelled to differ from the author on the subject of illustrations. The author says: "The omission of all illustrations of apparatus is a new departure." Is it a good one? We must remember that the beginner does not recognise by name even "the permanent apparatus commonly seen in laboratories," and although it is very desirable that "the student should be encouraged to devise his own apparatus," it is a process which is certain to result in failure and loss of time. Those who have attempted with all the knowledge of laboratory resources to reduce an apparatus to a simple form, will recognise how troublesome the process is. Moreover, the author gives no directions for working glass; which, one would suppose, would be the first step in fitting up glass apparatus.

May one further suggestion be offered? Experiment 1, in section ii., on homogeneous and heterogeneous substances, is not a single experiment at all, but a very condensed account of the separation of solids and liquids, in which filtration, sublimation, levigation, and fractional distillation are discussed in turn. This and some other chapters would be improved by dividing them up and by giving, in addition to general principles, a description of specific instances, from which the teacher might make his own selection.

There is no doubt that these volumes will form a useful addition to the modern literature on science teaching. J. B. C.

OUR BOOK SHELF.

Untersuchungen über Amylose und Amyloseartige Körper. By O. Bütschli. (Heidelberg: Carl Winter, 1903.)

THIS pamphlet of about 100 pages is a reprint from the *Proceedings* of the Heidelberg Association for Natural History and Medicine (vol. vii. part iii.), which is one of the best known of the German scientific societies. It illustrates a tendency, not infrequently seen in Germany, to utilise the pages of a journal for the issue of what is practically a book. The author, Prof. Bütschli, is well known to students of biology for his work on protoplasm, and distant as the subject of starch may at first appear from zoological studies, the present research is a direct outcome of the former. The microscopic investigation of various colloids occurring in nature which led Bütschli to his well-known hypothesis of the foam-like structure of protoplasm caused him later to direct his attention to the formation of starch grains, cellulose membranes and the like in the vegetable world. Some years ago he published his view that starch grains are of the nature of sphæro-crystals. From this he passed on to attempt to prepare starch grains artificially from starch solutions, and he was rewarded by the discovery that, under certain conditions, especially on evaporating a solution containing also 5 per cent. of gelatin, particles differing but slightly from natural starch grains are deposited. These results were criticised by Arthur Meyer, who expressed the opinion that these particles consisted not of starch, but of amylodextrin. The present pamphlet is a reply to these criticisms, and on the ground of various chemical reactions the conclusion is finally reached that Meyer was wrong, and the author right in his original contention.

This is the gist of the monograph, and its length is due to the fact that it became necessary for the author to make a chemical investigation of various starches, dextrins, and allied carbohydrates in order to justify his main conclusions.

From the purely chemical standpoint very little real progress is contributed to our knowledge of the carbohydrates. The sugars, thanks to Fischer and others, we now know something about, but concerning the

molecular size and constitution of the heavy carbohydrates, like starch and glycogen, and the family of dextrins intermediate between these and the sugars, we have at present little more than guesses to go upon. To give, as the present author does, long lists of reactions with iodine and other reagents, and on the strength of differences in these to describe as separate substances amylose, amylosan, amylodextrin, and other forms of dextrin, and to add to the list amyloporphyrin and amylorubin, does not really advance matters much. Bütschli apologises at the start for his lack of chemical knowledge, and in the end admits that several of his preparations are mere mixtures; we therefore fear that, from the chemists, his work will meet with but scant courtesy. He has nevertheless succeeded in producing a very readable little brochure, and if his main contention is accepted, his labours will not have been useless.

Lessons on Country Life. By H. B. M. Buchanan and R. R. C. Gregory. Pp. xi+330. (London: Macmillan and Co., Ltd., 1903.) Price 3*s.* 6*d.*

ONE of the authors of the above book, Mr. H. B. M. Buchanan, produced a little time ago two small "Country Readers," most excellent books for the children of a rural elementary school, in which our common domestic animals were discussed from a full knowledge in an easy, pleasant style. We are sorry we cannot give the same praise to the "Lessons" before us; the educational value of the former book has disappeared, and the authors have allowed a craving for completeness to swamp their judgment, so that the result is a miniature and scrappy encyclopædia instead of a book.

Country life is a vast subject, so vast that no child can learn during his school life even a fraction of the information it may be desirable he should possess in his after life; the teacher, then, must abandon the attempt to impart information, but devote his energies to instilling into his pupils the right way of looking at things, the method which they can employ themselves when going about the world. The method consists in a training in observation and experiment. Here instead we have first a sort of abbreviated textbook on live stock, hints on breeding and feeding, twelve breeds of cattle described at lengths varying from a page down to two lines, horses, sheep and pigs to correspond, analyses of milk, rules for making butter and cheddar cheese; with such a programme what chance is there of observation or experiment for school children?

The latter portion of the book deals with common birds and mammals in a much better spirit; strike out the unnecessary Latin names for orders, families and species, and it forms a fair reading book. The last section, on insects, is again spoiled by a wholly unnecessary passion for classification; classification is only grammar, and the parts of τυπτω are just as good in this way as "Coleoptera, Euplexoptera, Orthoptera, Thysanoptera, &c." We know by sad experience how easy the schoolmaster finds it to write these things on the blackboard and make his class copy them with due attention to neatness and spelling; observation and experiment require both labour and thought. We grieve to speak unkindly of Mr. Buchanan, who has done such excellent work before; there are good things in the book, *e.g.* the section on poultry and the illustrations, but, like the curate's egg, it is only good "in parts." If the new teaching on country life is to succeed in our schools, it will be in virtue of the spirit, and not of the information which the teacher imparts to his pupil, and we consider that this book fatally misses the spirit.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radio-activity and the Age of the Sun.

IN the Appendix E of Thomson and Tait's "Natural Philosophy," Lord Kelvin has computed the energy lost in the concentration of the sun from a condition of infinite dispersion, and argues thence that it seems "on the whole probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say, with equal certainty, that inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless sources now unknown to us are prepared in the great storehouse of creation."

The object of the present note is to point out that we have recently learnt the existence of another source of energy, and that the amount of energy available is so great as to render it impossible to say how long the sun's heat has already existed, or how long it will last in the future.

The lost energy of concentration of the sun, supposed to be a homogeneous sphere of mass M and radius a, is $\frac{2}{5}\mu M^2/a$, where μ is the constant of gravitation. On introducing numerical values for the symbols in this formula I find the lost energy to be $2{\cdot}7\times10^7$ M calories, where M is expressed in grammes. If we adopt Langley's value of the solar constant this heat suffices to give a supply for 12 million years. Lord Kelvin used Pouillet's value for that constant, but if he had been able to use Langley's his 100 million would have been reduced to 60 million. The discrepancy between my result of 12 million and his of 60 million is explained by a conjectural augmentation of the lost energy to allow for the concentration of the solar mass towards its central parts. I should have thought the augmentation somewhat too liberal, but for the present argument it is immaterial whether it is so or not.

Now Prof. Rutherford has recently shown that a gramme of radium is capable of giving forth 10^9 calories. If, then, the sun were made of such a radio-active material it would be capable of emitting 10^9 M calories without reference to gravitation. This energy is nearly forty times as much as the gravitational lost energy of the homogeneous sun, and eight times as much as Lord Kelvin's conjecturally concentrated sun.

Knowing, as we now do, that an atom of matter is capable of containing an enormous store of energy in itself, I think we have no right to assume that the sun is incapable of liberating atomic energy to a degree at least comparable with that which it would do if made of radium. Accordingly, I see no reason for doubting the possibility of augmenting the estimate of solar heat as derived from the theory of gravitation by some such factor as ten or twenty.

In an address to Section A of the British Association in 1886 I discussed the various estimates which have been made of geological time, and I said, "Although speculations as to the future course of science are usually of little avail, yet it seems as likely that meteorology and geology will pass the word of command to cosmical physics as the converse." I think the recent extraordinary discoveries show that this forecast was reasonable.

It is probable that the bearing of radio-activity on the cosmical time-scale has occurred to others, but I do not happen to have seen any such statement.

Cambridge, September 20. G. H. DARWIN.

The Principle of Radium.

WOULD some of your readers inform me whether the case of the radium phenomena is quite unique? When a small magnet in my drawer has been ready to act on a compass at any time during the last twenty years, and has not